

Prevention and Control of Wind  
Erosion of High Plains Soils  
in the Panhandle Area

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PREVENTION AND CONTROL OF WIND EROSION OF HIGH PLAINS SOILS 4.  
IN THE PANHANDLE AREA

- By -

H. H. FINNELL

Soil Conservation Service

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Prevention and Control of Wind Erosion of High Plains  
Soil in the Panhandle Area

By H. H. Fennell

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Natural Conditions:

School of Forestry

Physiography - The elevation above sea level increases from about 2000 feet along the eastern border of the High Plains to about 5000 feet along the Rocky Mountain base on the west. This eastward slope averages about 15 feet per mile. The topography of farm lands is gently rolling with slopes of more than 2% rare. The majority of farms average 1% slope or less. The rough and broken lands along the streams are often stony and steeply sloping. These are used almost exclusively for grazing. On the plains numerous isolated depressions contribute small watersheds draining into shallow wet weather lakes. The watersheds of the stream are comparatively narrow and the network of tributaries not well developed as is commonly found under more humid climates.

Climate - The climatic conditions as recorded by the U. S. D. A. Field Station at Dalhart, Texas, are representative in nature of the area as a whole and are summarized in the following tabulation:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall, ins	.19	.35	.75	1.64	2.71	3.22	2.34	2.73	1.41	1.69	.54	.47	18.50
Temp, mean, deg.	33	36	43	53	63	72	77	75	68	55	43	32	54
Frost dates				23						16			
Wind, mi. per hr	6.5	7.2	8.3	8.8	8.1	6.9	6.1	5.5	6.0	6.2	6.3	6.2	6.7
											(Seasonal)		
Evaporation, ins.				6.97	8.67	9.59	10.05	9.03	7.16				51.13



The fluctuation from normal in the amount and distribution of rainfall is probably one of the most characteristic features of this region. The fitness of the area for agricultural development has been experimentally demonstrated, but the farmers have generally failed to maintain a stabilized production. This has not been because of seasonal deficiencies as much as because of a failure to adjust cropping plans to the variations of seasonal conditions. The climatic resources loom to a larger proportional importance compared to soil resources than they are usually credited with either under humid or irrigated farming. The moisture supply in particular is capable of better utilization than is commonly practiced.

Native Vegetation - Quoted from Carter: 1910;

Amarillo Sandy Loam- "On the High Plains a considerable growth of the bear grass (*Yucca angustifolia*) is found, while the wormwood (*Artemisia filifolia*) is a characteristic growth on the type throughout the region. Sedgegrass (*Andropogon* sp.) is the common grass and together with other grasses makes good grazing."

Amarillo Loam- "The Amarillo loam exists as an open prairie covered with a growth of native prairie grasses. These have long been valued for stock grazing, owing to their high nutritive qualities. Mesquite grass (*Bouteloua oligostachya*) and buffalo grass (*Buchloe dactyloides* or *Bulbilis dactyloides*) are the two most common as well as the most valuable grasses on the type."

Amarillo Silty Clay Loam- "The surface of this soil is heavily carpeted with a growth of short prairie grasses. These grasses though short are very palatable and nutritious, and in the fall cure on the ground and are therefore very valuable for stock. For many years this type was used exclusively for stock grazing and it is still devoted largely to this purpose. The two

The fluctuation from normal in the amount and distribution of rainfall is probably one of the most characteristic features of this region. The fitness of the area for agricultural development has been experimentally demonstrated, but the farmers have generally failed to maintain a stabilized production. This has not been because of seasonal fluctuations as much as because of a failure to adjust cropping plans to the variations of seasonal conditions. The climatic resources seem to a larger proportional importance compared to soil resources than they are usually credited with either under humid or irrigated farming. The moisture supply in particular is capable of better utilization than is commonly practiced.

Native Vegetation - Quoted from Carter 1910:

Amabilis Sandy Loam - "On the High Plains a considerable growth of the best grass (*Luzon angustifolia*) is found, while the warmwood (*Artemisia filifolia*) is a characteristic growth on the type throughout the region. Sedgework (*Andropogon* sp.) is the common grass and together with other grasses makes good grazing."

Amabilis Loam - "The Amabilis loam exists as an open prairie covered with a growth of native prairie grasses. These have long been valued for stock grazing, owing to their high nutritive qualities. Mesquite grass (*Bouteloua oligoneura*) and buffalo grass (*Bouteloua dactyloides* or *distachya*) are the two most common as well as the most valuable grasses in the type."

Amabilis Silty Clay Loam - "The surface of this soil is heavily carpeted with a growth of short prairie grasses. These grasses though short are very palatable and nutritious, and in the fall serve on the ground and are therefore very valuable for stock. For many years this type was used exclusively for stock grazing and it is still devoted largely to this purpose. The two

Principal grasses found on this type are buffalo and mesquite (gramma) grass. No trees are found except an occasional small mesquite near the edge of the High Plain bordering the escarpment. In some places, especially where the surface is quite level, a weed locally known as turpentine weed (*Gutierrezia sarothrae*) is very abundant."

Soils - Quoted from Carter, 1910;

Amarillo Sandy Loam - "The surface soil of the Amarillo sandy loams consists of 12 to 14 inches of a brown or reddish-brown medium to fine sandy loam. It is very loose and friable in structure and is often very nearly a loamy sand. The surface for a few inches has only a low content of organic matter. In some areas the soil consists of rather coarse sand grains, but in general the sand is mostly medium and fine in texture."---  
"The subsoil of the Amarillo sandy loams consists of a sandy loam to sandy clay ranging in color from brown to red, but being chiefly a reddish brown. Throughout a considerable proportion of this type a white calcareous material is found in the subsoil at a depth of 20 to 30 inches."---  
"The Amarillo sandy loams have been formed from sandy deposits of Tertiary or Quaternary age. Much of the material probably came from the Red Beds, which would account for its red or reddish-brown color. It is not clear whether it was deposited over the whiter calcareous material or weathered from the more sandy portions, the reddish color being developed during the processes of weathering. The reddish color of the Amarillo silty clay loam which is undoubtedly derived from the underlying white clay, would seem to support the latter theory."---  
"The areas of the Amarillo sandy loam are gently rolling to rolling in topography while in some places the surface is rather broken and could be tilled only with difficulty. However, the greater part of the land is rolling and could be cultivated."

(Principal grains found on this type are buff and micaceous (quartz).  
The grains are found mostly in occasional small nodules near the  
edge of the High Hill. In some places, especially  
where the surface is water level, a wood locally known as *Juniperus* wood  
(*Juniperus occidentalis*) is very abundant."

Section - Grand Lake Canyon, 1930:

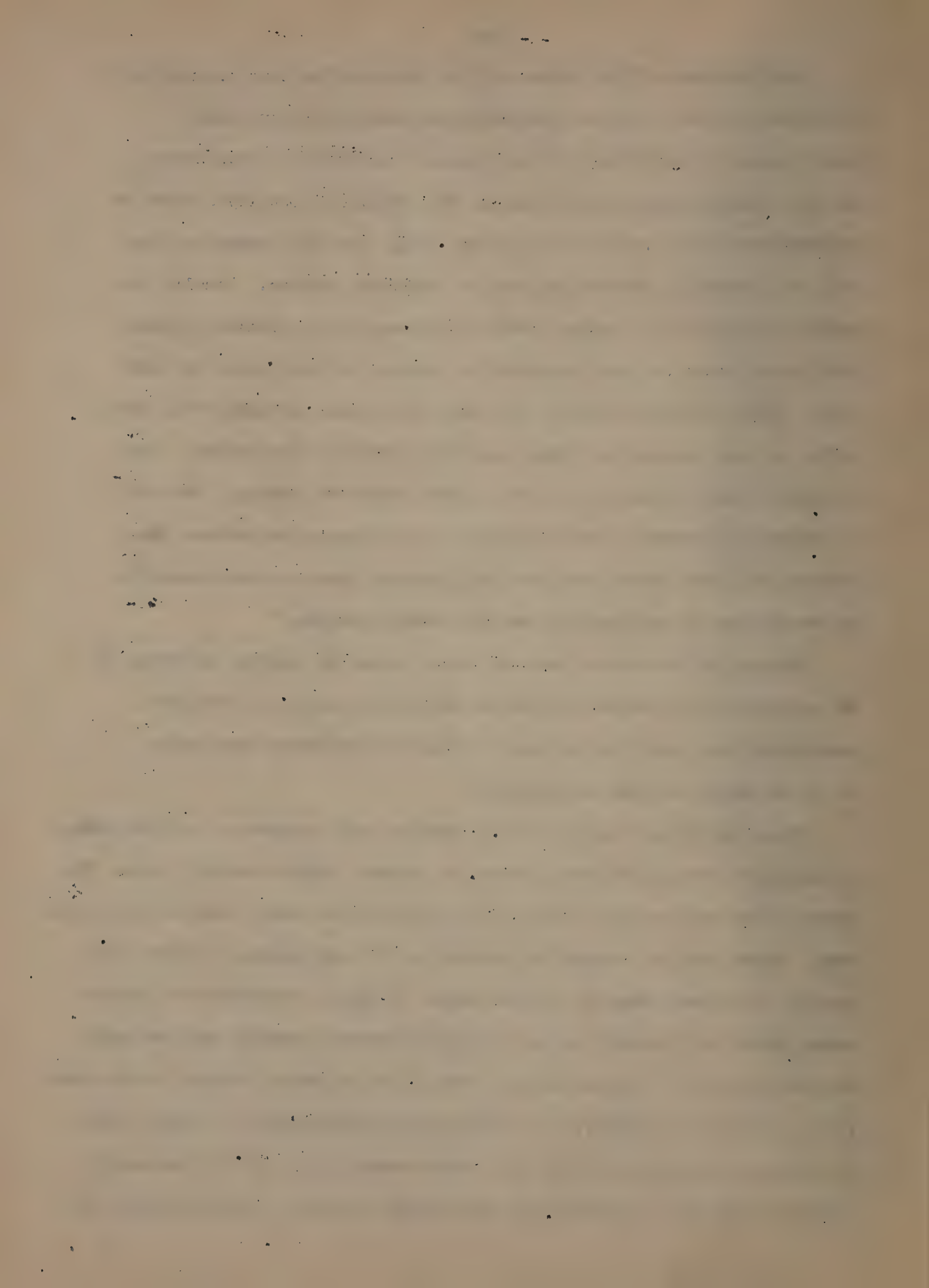
Amabilis Sandy Loam - "The surface soil of the Amabilis sandy loam

consists of 15 to 30 inches of a brown or reddish-brown medium to fine  
sandy loam. It is very loose and friable in structure and is often very  
loose and sandy. The surface for a few inches has only a few contents  
of organic matter. In some places the soil consists of rather coarse sand  
grains, but in general the sand is mostly medium and fine in texture."  
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to rolling in topography while in some places the surface is rather broken  
and could be tilted only with difficulty. However, the greater part of the  
land is rolling and could be cultivated."

Amarillo Loam - "The surface soil of the Amarillo loam consists of a dark brown, brown, sometimes reddish-brown loam to a heavy sandy loam ranging in depth from 8 to 14 inches. When wet the areas having the dark surface appear nearly black. The subsoil is usually a brown or reddish-brown heavy loam to heavy sandy loam. The sand content of the soil and subsoil is principally fine to medium in texture. Usually at a depth of from 18 to 30 inches a white calcareous clay, similar to that found under other soils of the Amarillo series, is found below the subsoil. Small calcareous nodules are also often found throughout the subsoil. In some places where this calcareous material lies within a foot or less of the surface the soil has little value for farming. The soil is friable in structure when cultivated but on drying out without cultivation it packs rather hard."---"The Amarillo loam has been formed by the weathering of the Tertiary and Quaternary deposits."

"On some of the slopes near the high plains the shallow condition of the soil has been produced by erosion which has resulted in the white substratum being near the surface."---"On the High Plains the surface is on the whole slightly undulating."

"Amarillo Silty Clay Loam - "The surface soil consists of a light brown or chocolate brown silty loam, having in places a slight reddish tinge. The depth of the soil varies from 2 to 8 inches, but the usual depth is 3 to 5 inches. Below this the subsoil to a depth of 18 to 24 inches is redder and heavier in texture than the surface soil. It may be described as a reddish brown silty clay loam with a hard compact structure. Usually this material does not persist to a depth of more than 24 to 30 inches, though in rare cases it may extend to 36 inches. At a depth ranging from 18 to 30 inches spots of a white calcareous material are always encountered, and this calcareous material increases in amount with depth until at 4 to 5 feet it becomes al-



most a solid white mottled with red. The surface soil is friable and easily tilled after the first plowing, but contains sufficient clay to make it quite compact and firm on drying out when not cultivated."---"The topography of the Amarillo Silty clay loam is remarkably uniform. The surface is gently undulating to gently rolling and in many places has an extremely level appearance as far as the eye can reach."

Agricultural History - From the time of earliest occupation by hunters through the development of cattle grazing very little land was put into cultivation. All evidences of wind erosion were confined to narrow belts along some of the stream courses and to occasional round-up grounds or watering places where the native vegetation was destroyed by trampling. Settlement of this region by cattlemen occupied a rather lengthy period toward the close of the Nineteenth century and any production of cultivated crops during this time was rather incidental to the cattle industry than significant as an independent productive enterprise. The pioneering stage of farm development took place roughly during the period of 1900-1920. Settlers during this time broke out from native sod and placed in cultivation relatively scattered areas of farm land, but it was not until after the World War that a feverish expansion of agriculture took place in this region. In many localities at the present time practically all of the suitable plow land has been placed in cultivation. In many cases land that has only been in cultivation 10 to 15 years has been seriously and permanently damaged by wind erosion. Water erosion, as a matter of fact, is also to be contended with though its effects are less noticeable.

Crops - The utilization of cultivated lands has been determined almost entirely by the adaption of crop types to the soil textures. Heavy to loam soils are usually sown to wheat, while the sandy loams to loamy sands are planted to sorghum and corn. Grain sorghums is the type most widely grown except



in certain areas of specialized corn production. Considerable forage sorghum and broomcorn are also grown. The specific adaptations of crop types and also the operative difficulties developing in an attempt to use the winter grains and sorghum crops in rotation has encouraged continuous propping practice throughout the area. The variability of seasonal distributions of moisture supply require a flexible cropping plan in order to utilize to the best advantage the combined soil and climatic resources of the country. The development of such crop and soil management is now in its beginning, but fits essentially into any conservative erosion control program.

The soil types described above and the crops enumerated by no means cover the entire range of soils and crops found in the greater Panhandle area, but will serve for purposes of this discussion to represent the more specific problems arising from cultivation. Soil and crop relations largely determine the relative importance of different means of eliminating erosion hazard.

Human Resources - The farm population of the semi-arid belt are possessed, as a general rule, of certain characteristics naturally assorted from the American people as a whole during the process of migration. That they are willing to face new problems with new methods is evidenced by their presence here. Their adaptability has been proved by the farming apprenticeship to which they have been subjected in the very recent pioneer development of this area. Much remains to be learned about the efficiency of resource utilization and the conservation of resources because many of the conditions affecting them are of recent occurrence. The fact that no hard and fast system of agriculture has become established as a result of generations of uniform practice leaves

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The way open to ready response in the minds of farmers of this area to efforts being made to introduce erosion prevention methods of management.

### The Causes and Control of Wind Erosion.

Natural Erosion Control - In its native state the lands of the High Plains region were occupied by that vegetation which the experience of centuries had proved best equipped to thrive under each particular soil and climatic condition. In some semi-arid areas the concentrated surface waters have in modifying the topography gained the upper hand and no type of natural vegetation has been able to halt erosion by water. However, even the rough and broken lands have had sufficient natural cover to control wind erosion. Of course, the less rolling lands have accumulated the best stores of fertility being less subject to any kind of erosion and these have been selected by the pioneer to be put into cultivation.

Under natural conditions they were never exposed to wind action even during prolonged drouths because the residue of the last season's growth remained as a protective covering until rains, however delayed, came to stimulate new growth.

Erosion Hazard under Cultivation - The destruction of the natural cover incident to placing the land in cultivated crops creates a necessity of maintaining an effective substitute for the original covering. If this is not done even short periods of soil exposure to the wind may allow severe erosion to take place. The maintenance of an adequate vegetative cover, therefore, becomes the goal of practically all of the wind erosion control methods. The soil blowing hazard has always been greatest in seasons of drouth, after crop failures and in places or on soil types less disposed to accumulate moisture. Thus, contrary to the conditions encouraging water erosion where the greatest erosion hazard exists at the point of greatest water concentration, the wind erosion hazard develops at the



point of least water concentration.

The obstacles to be overcome are so erratic in their occasional cumulative preponderance that nothing short of a thorough coordination of every possible effort can be relied on to maintain wind erosion control. Any successful program must also be one that prepares in advance for any emergency that experience proves might be expected. To repair erosion damage is not altogether possible. If it were it would always be costly without profit. A repair operation, regardless of how necessary it may be, is always an unproductive expense. In the struggle against wind erosion preparations made 10 to 20 months previous will often save the day. If they are made in the course of a productive crop management they become a part of the productive economics, and at the same time serve to protect the capital investment.

In the detailed discussion of methods applicable to the High Plains for wind erosion control emphasis will be laid on the preventive program and a separate section devoted to reclamation problems where erosion has been permitted to take place.

Management of Crop Residues - Adapted crops which leave erosion resisting residues are wheat, barley, oats and rye among the winter and spring small grains. Foremost of those in use is winter wheat. Row crops which leave erosion resisting residues are all of the sorghum family and include milo, kafir, hogari, broomcorn, sudan grass and all the other forage sorghums. However, the production of any of these crops does not necessarily give erosion protection to the soil on which they are grown. The residues must be conserved and utilized for that specific purpose.

The ideal system of management would require that the vegetative covering be not disposed of until soil moisture sufficient to insure the successful



start of the next crop has been accumulated in the soil. The growing crop then perpetuates the ground cover and provides at the close of the season a renewal of the residue supply.

To maintain an adequate vegetative cover in the form of erosion resisting residues from productive crops, unusual measures are justified to prevent burning off of stubbles and the overgrazing of stalk fields. Some of the worst cases of wind erosion to be found in the Panhandle area are directly traceable to these two destructive practices. Rank wheat stubble has often been burned because of the mechanical difficulty of working it into the soil and because of the temporary fertility depression that follows. There is no denying these two objections but they are more than compensated by the protection of the soil from wind erosion. In addition to this the presence of organic matter in the topsoil has been definitely proved to increase the rate of absorption and the water holding capacity. If a drouthy season follows this advantage more than offsets the fertility depression. If another favorable season follows the opposite is true, but the odds against two bumper crops in succession are too high to gamble on when the cost includes a serious risk of soil exposure to erosion. Another practice that has resulted in just as disastrous consequences is that of selling out stalk fields to outside herasmen who almost invariably leave the cattle in the field until the last scrap of vegetation has been consumed. Moderate stalk field grazing should be practiced for the benefit of farm livestock, but in any case a careful watch should be kept to remove them when the effectiveness of the ground cover is threatened.

Where sorghum crops are cut with a binder to make roughage removed from the field for feeding purposes one of two precautions should be taken.

The first part of the report deals with the general situation of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

The second part of the report deals with the financial situation of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

The third part of the report deals with the social situation of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

The fourth part of the report deals with the economic situation of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

The fifth part of the report deals with the political situation of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

The sixth part of the report deals with the cultural situation of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

The seventh part of the report deals with the educational situation of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

The eighth part of the report deals with the health situation of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

The ninth part of the report deals with the environment situation of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

The tenth part of the report deals with the foreign relations of the country and the progress of the work. It is followed by a detailed account of the various projects and the results achieved. The report concludes with a summary of the work done and the prospects for the future.

A uniform stubble one foot high may be left or regular strips 4 to 6 rows wide may be headed and the intervening space of 20 to 30 rows harvested for forage. A good stand of any of the sorghum varieties will give soil protection from the wind if adequate stubble height or frequency of strips is insured, but these varieties of profuse stooling habit make the best cover.

The disposition of erosion resisting residues should be accomplished according to the circumstances of the season. Heavy wheat stubble and thick stubbles of close drilled sorghums left one foot high may be worked into the surface soil as soon as convenient. They will offer a prolonged resistance to blowing even with a relatively smooth surface exposure, though lister tillage may be preferred for other reasons. The stubble or strips left after a row crop has been harvested should remain untouched as long through the winter as their effectiveness in that condition holds out or until seasonal conditions warrant the beginning of preparations for the ensuing crop.

When erosion non-resisting crops like corn are desired, strip cropping with a suitable sorghum becomes necessary. If the crop is being grown on light sandy soil which does not require contour tillage for runoff conservation the rows may be run counterwise to the prevailing winds, but a closer spacing of the erosion resisting strips is recommended than where contour tillage is followed. The windbreak strips should not be less than 4 rows wide, but may be wider depending on the number of rows listed or cultivated at one time. Common yellow milo with the grain headed and the tall stubble left standing makes an ideal variety for this purpose though many other varieties can be well used. The width of main crop strips under severe conditions should not be wider than 20 rows, but this can be varied with experience according to soil type, direction of rows

[The text on this page is extremely faint and illegible. It appears to be a multi-paragraph document, possibly a letter or a report, but the specific content cannot be discerned.]

and type of crops involved.

Where both drilled and row crops are produced on the same farm and it has been found convenient to strip the terraced fields to provide length of row for cultivated crops, and additional advantage can be had by using a winter grain in the drilled strips and triangles. This reduces to a fine point the application of a principle of crop diversification which experiment has shown to be especially useful in the semi-arid southwest. No systematic cropping plan either of continuous culture or rotation has been discovered which can equal in economy of production a flexible cropping plan which takes into consideration the initial soil moisture and fertility conditions of individual fields at each successive planting period of the year. So if provision is made for the utilization of every adapted crop type as seasonal opportunity affords and the sowed and rowed crops are selected from the winter and summer groups as above the surety of protective cover in any one field is greatly increased.

Otherwise the variable cropping plan would necessitate the more frequent use of emergency cover crops unless extreme precaution in residue conservation were observed. The increased dependability of production under the variable system somewhat offsets the reduced frequency of cropping, from the standpoint of maintaining a vegetative cover.

Loss of Vegetative Cover - Where the normal residues of productive crops are depended on the loss of cover may be expected, but can be excused only if the result of drouth. Over-grazing, misuse and burning of residues must be avoided strictly. The loss of vegetative cover as a result of crop failures due to drouth can be treated in two ways. First and foremost in importance is moisture conservation which affords an opportunity by advance preparation to avoid or modify crop failures.



Second and supplementary to moisture conservation is the planting of off season emergency cover crops. This is a measure which should not be resorted to unless the residues of normal crops bolstered up by moisture saving fail to give the needed continuance of vegetative cover, but should always be held in reserve in case of such emergency.

Continuance of Vegetative Cover by Moisture Conservation -On deep sandy loam soils the utilization of moisture for crop production is naturally most efficient and little if anything can be done mechanically to increase it. However, on loam soils and to a greater extent on silty clay loam soil there is a constant opportunity to increase the available moisture supply by conserving runoff water. Rainfall records and runoff observations show that these losses occur even in years of the worst drouth. It has often happened that the only effective rain of an entire crop growing season is one of excessive character. Sometimes the entire moisture supply falls during the preparatory period and when a portion of this is of excessive character the importance of increasing the quantity stored in the subsoil is great.

Considered from the viewpoint of wind erosion control it is almost as important to have a uniform distribution of moisture supply within a field as to achieve any measure of total conservation. A drouthy knoll or slope of just a few acres may start erosion that will spread as a menace to well watered parts of the same or adjacent fields.

Thus terracing and contour tillage, which have been demonstrated capable of increasing the average soil moisture supply about 25% under High Plains conditions on heavy soils, become a very material support to the vegetative program. This type of soil management results in saving water for productive purposes at the point of origin where it is most often needed to help bridge drouthy periods in the maintenance both of economic stability and a vegetative cover for erosion prevention.



In the area of 20 inches average annual rainfall or less all terraces on gently rolling and nearly level land should be made level with closed ends and high enough to back up water to the base of the next terrace. The most practical interval adjustment can be determined by linear spacing or terrace area rather than by vertical spacing. The average distance between terraces on silty clay loam soil to be used mainly for small grain growing which is best suited to plains farming methods is 125 to 150 feet. On typical areas of this soil type the vertical interval would range from .40 to 1.00 foot, the effective height of the terraces being adjusted accordingly. Where unusual unevenness occurs covering a small area of a field splice terraces should be introduced where the distance exceeds 250 feet and sections eliminated where the distance falls below 75 feet. All terraces thus ending in midfield must have closed ends the same as those abutting the edge of the field. It sometimes becomes necessary to change the vertical interval within a field but not often. The thing to keep in mind on the High Plains is that the terrace is designed to retain the water that falls within a given area. Dealing with slopes that average less than 1%, relatively small variations in slope cause extremely wide variations in linear spacing where a fixed vertical interval is followed. This fact together with the importance of a uniformly spaced water belt distribution makes adjustment of vertical interval and terrace height more desirable than disregarding the distance between terraces.

The cross section suited to wheat farming is low and broad. Particularly important is a broad crown which facilitates maintenance under wheat growing machinery. A properly built wheatland terrace can be cultivated and drilled upon the same as any other part of the field and maintained with one annual turn of the one-way disk plow around the terrace throwing soil back on the terrace.

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Contour listing of wheat stubble is recommended in preparation for the next crop when it can be accomplished within one month of harvest under favorable soil moisture conditions. Ample July rainfall would be considered an invitation to list. Below normal July rainfall would indicate best results from shallow level tillage. All listing of terraced wheat land should parallel or nearly so with the terraces so that no listing furrows lids in Algrado sufficient to bring a head of water against the terrace. Otherwise an unusual amount of terrace maintenance will be required to keep the system in effective condition.

Terracing of loam type soils used for diversified farming should be done in the same fashion as described for wheat land excepting that a distance of 150 to 200 feet between terraces makes a terrace area giving rise to no more surface runoff than the narrower area recommended for heavier soil. If row crop production alone is to be practiced on loam soil a narrower base may be used if preferred, but in all cases under semi-arid conditions a terrace base of 30 feet or more is desirable.

On the sandy loam soils very little runoff has been observed, but in some areas of shallow phase types contour listing is useful to maintain even distribution. Unless the slopes are relatively abrupt and uneven a general field contour without point rows will serve the purpose. On most fields of sandy loam to loamy sand there is nothing to be gained by efforts toward runoff conservation.

Continuance of Vegetative Cover by Off-season Planting - When the best possible utilization of normal crop residues produced under a continuous or variable cropping system supported by effective moisture conservation has failed to afford the necessary vegetative cover to assure wind erosion prevention the use of emergency cover crops is fully justified.



An example most frequently observed in row crop farming is when the planting season in summer has passed without rainfall enough to enable the securing of a crop stand. Rains may come later in the summer, too late to make a crop, but if the protective residue of the proceeding crop has disappeared a stooling sorghum such as sudan grass, hegari or dwarf yellow milo should be planted to renew the ground covering for the winter. When wheat fails and the summer season is approached with the land in a bare condition a dual purpose planting of wide row sorghum for grain is in order. Instead of fallowing the land in preparation for the next wheat crop, milo or similar crop grown in rows 10 to 15 feet apart permits a very desirable partial fallow effect and at the same time gives a stubble protection against blowing until the wheat has an opportunity to cover the ground. The grain production from such plantings often give a welcome substitute income.

The principle to be followed in the use of cover crops can be referred to in working out a satisfactory plan for any situation and may be stated as follows: A cover crop should be introduced with the first available moisture after the danger of loss of vegetative cover becomes apparent, it should be an adapted erosion resisting variety suited to the time of year in which the emergency arises, and it should be disposed of in time or so planted in a way as not to interfere materially with the preparations for the next regular crop.

Windbreak Trees - While the rainfall will not support trees in every location they may be desired, there is an opportunity to contribute materially to erosion control by utilizing natural and engineered sites for tree row windbreaks.

The usefulness of trees in wind erosion control lies mainly in giving a border protection to cultivated fields which may start to blow as a result of exposure to dust swept from bare roadways. The presence of scattered windbreaks throughout the community is expected to have a more or less

1. The first part of the document is a letter from the President of the United States to the Congress, dated January 3, 1862. It contains a report on the state of the Union and the progress of the war against the rebellion. The President mentions the success of the Union arms and the determination to bring the rebellion to a speedy end.

2. The second part of the document is a report from the Secretary of the Treasury, dated January 10, 1862. It contains a detailed account of the financial condition of the government and the measures taken to meet the expenses of the war. The Secretary mentions the success of the government in raising money and the determination to maintain the credit of the Union.

3. The third part of the document is a report from the Secretary of the Interior, dated January 15, 1862. It contains a detailed account of the land and mineral resources of the United States and the measures taken to develop them. The Secretary mentions the success of the government in securing the land and mineral rights of the Union and the determination to promote the interests of the people.

4. The fourth part of the document is a report from the Secretary of the Navy, dated January 20, 1862. It contains a detailed account of the naval operations of the United States and the progress of the war against the rebellion. The Secretary mentions the success of the Union fleet and the determination to bring the rebellion to a speedy end.

5. The fifth part of the document is a report from the Secretary of the War, dated January 25, 1862. It contains a detailed account of the military operations of the United States and the progress of the war against the rebellion. The Secretary mentions the success of the Union army and the determination to bring the rebellion to a speedy end.

6. The sixth part of the document is a report from the Secretary of the State, dated January 30, 1862. It contains a detailed account of the diplomatic relations of the United States and the progress of the war against the rebellion. The Secretary mentions the success of the Union in securing the support of the other nations and the determination to bring the rebellion to a speedy end.

7. The seventh part of the document is a report from the Secretary of the Education, dated February 5, 1862. It contains a detailed account of the educational system of the United States and the progress of the war against the rebellion. The Secretary mentions the success of the Union in securing the support of the other nations and the determination to bring the rebellion to a speedy end.

8. The eighth part of the document is a report from the Secretary of the Agriculture, dated February 10, 1862. It contains a detailed account of the agricultural system of the United States and the progress of the war against the rebellion. The Secretary mentions the success of the Union in securing the support of the other nations and the determination to bring the rebellion to a speedy end.

9. The ninth part of the document is a report from the Secretary of the Commerce, dated February 15, 1862. It contains a detailed account of the commercial system of the United States and the progress of the war against the rebellion. The Secretary mentions the success of the Union in securing the support of the other nations and the determination to bring the rebellion to a speedy end.

10. The tenth part of the document is a report from the Secretary of the Finance, dated February 20, 1862. It contains a detailed account of the financial system of the United States and the progress of the war against the rebellion. The Secretary mentions the success of the Union in securing the support of the other nations and the determination to bring the rebellion to a speedy end.

general effect in breaking up the surface wind currents which otherwise sweep the ground without obstruction.

Trees planted along highways should be placed on the south or east sides of the road, in order to prevent the blocking of traffic during winter months by snow drifts. Sites naturally favorable exist along level stretches of the roadway where surface waters collect, stand in the ditch and soak into the soil, thus providing an important additional moisture supply to enable tree maintenance without cultivation or irrigation. Other naturally favorable locations may be found along drainage ways and small lakes in pasture areas adjacent to farm lands. The control of drainage water from roadways by means of loose rock dams, supported by appropriate vegetation, may also serve to extend the site in either direction. Such engineered tree sites should be developed with strict regard to the area, supplying them with drainage water. It is possible also to obtain water in some cases for the support of trees by the use of diversion structures.

Species which have proved their hardiness in the Panhandle area and which are suitable for windbreak plantings are: Chinese Elm (*Ulmus parvifolia*) Apricot (*Prunus aroniaca*) Russian Milberry (*Morus alba tatarica*) Honey Locust (*Gleditsia triacanthos*) Flowering Willow (*Chilopsis linearis*) Russian Olive (*Elaeagnus angustifolia*) Green Ash (*Fraxinus*) Cottonwood (*Populus*) and Tamarisk (*Tamarix*).

Where larger sized tree stock is set out some effective temporary protection against rabbit injury is necessary until tree is large enough to withstand rodent attacks. However, if whips are set out, which would undoubtedly be the economical plan, it is thought better to provide a permanent rabbit guard of wire netting. The species of trees best suited to various soil types and various degrees of moisture supply can best be determined by trial. However, it has been recommended generally that the



trees stand from 8 to 10 feet apart in the row with interplantings of the more shrub like species such as Tamarisk and Flowering Willow.

### Use of Tillage Operations in Erosion Control

When the soil is bare any kind of tillage, which will roughen the surface, gives a temporary protection from erosion. Two general objectives may be set up in considering this phase of erosion prevention namely: ridging or clodding the surface soil and raising heavy sub-soil material to the surface.

Among the implements which have been used for the first mentioned purpose are lister, shovel or sweep cultivator, the on-way disc with each second or third disc left on, the deep furrow drill the spike tooth harrow, plow and pocket digger. Implements which have been used for the latter named purpose are the chisel, sub-soil plow, mildboard plow, lister, the disc plow and grading machine.

The clodding effect of shallow tillage, especially on snady loam soil, can often be increased by doing the job while the soil is wet. The object of raising heavier soil material from the sub-surface is to produce a more cloddy structure where the surface soil has become shifty. Operations of this character, though costly, may under certain conditions do permanent good, but they should be considered more as a temporary substitute for the desired vegetative cover. Organic matter in the surface soil serves the same purpose and possesses also certain other advantages in addition to costing less. The most important advantages of vegetative control, as compared to mechanical control, are that vegetative covering renewed once a year gives more lasting protection and that it is important from the standpoint of maintaining soil fertility and keeping up the rate of moisture absorption to a high point.

Tillage methods at best afford only temporary relief and must be



repeated at intervals during the season, all of which is done at an expense which is usually unproductive. In no case should tillage operations for erosion control be continued after an opportunity arises to start either a regular crop or an emergency cover crop. It is not intended to minimize the importance of soil mechanics but to point out the waste of relying unnecessarily on such methods. They should be used diligently when all other measures have failed, serving as a fourth line of defense against wind erosion.

Where erosion prevention tillage can be combined with necessary soil preparation or moisture saving practices the usefulness of the operation is much increased. In this connection it is needless to say that any tillage operations on soil requiring contour treatment should, for the best moisture utilization, always be carried out on the contour.

### Reconditioning Lands Damaged by Wind Erosion

#### Character of Erosion

The most common effects of wind erosion consist of removing the topsoil to the depth of plowing and piling it up in hummocks or drifts of wind blown soil. A common condition of neglected fields is to find the topsoil blown out on some areas and piled up in others. Hummocked fields are sometimes so rough a tractor can not be driven over them. Frequently considerable irregular parts of the field may be filled in to a depth of 6 to 18 inches by soil transported from another part of the same field. Too often the topsoil has been carried completely away and deposited in fence rows, roads, about buildings or any other obstruction which may serve as a wind barrier.

The first step toward reconditioning wind eroded soil is to accumulate a moisture supply and level where necessary to permit ordinary farming operations, in order that either a regular crop or an emergency cover crop may be obtained at the first available opportunity.



Hummocks and drifts are usually formed about weeds and contain a relative high amount of unrotted organic matter, though much of this may be in a finely divided condition. To return areas of this kind to a productive state of fertility ample moisture supply is necessary. During droughty times a considerable period may be required to obtain this and whatever tillage treatment may be necessary to prevent further erosion must be carried out. When opportunity presents itself to bring the land under vegetative control again it should be immediately utilized.

The same may be said of areas where the topsoil has been removed, excepting that the greatest need in this case is a renewed supply of organic matter, which can only be accumulated from successive crops.

If the necessary moisture conservation measures have not already been put into effect this work may be combined with the reconditioning operations and may aid materially in hastening an opportunity for the first crop, by increasing the moisture supply and improving the natural moisture distribution.

### Summary

The experiences of recent years impress the fact that erosion by wind if prevention is neglected is capable of quick destruction of the usefulness of farm lands and must be resisted by every available control method. A prevention program with all phases practically coordinated to afford advance preparation against drought hazards is essential. Where erosion damage has already occurred, emergency methods and land reconditioning are necessary before a permanent preventative program can be established. The control methods representing successive lines of defense against wind erosion are enumerated in the order of their relative importance.

1. Utilization of erosion resisting residues.
2. Moisture conservation for maintenance of vegetation.



3. Emergency cover crops.
4. Windbreak tree plantings.
5. Emergency tillage operations.

Residue utilization, moisture conservation and tree plantings should be established parts of every high plains farming system. Those erosion prevention measures constitute economic assets to a permanent and stabilized plains agriculture by making material additions to the operating efficiency and natural resource conservation. Emergency cover cropping and emergency tillage should be held in reserve for support of the permanent erosion prevention program to be resorted to in case of extremely severe combinations of unfavorable conditions.

It is not possible to determine the exact date of the  
first appearance of the word "computer" in English.  
The word "computer" is derived from the Latin word "computare",  
which means "to calculate".

The word "computer" was first used in English in the 15th century.

Summary Outline of Wind Erosion Control Details

I. Utilization of Erosion Resisting Crop Residues.

1. Strip Cropping.

- a. Erosion resisting and non-resisting crops.
- b. Summer and Winter season crops.

2. Prevention of burning.

- a. Small grain stubble and straw.
- b. Drilled forage or hay crop stubble.
- c. Weeds.

3. Prevention of over-grazing.

- a. Growing pasture crops.
- b. Winter small grains.
- c. Stalk fields.

4. Delayed disposition of residues.

- a. Sparse drilled crop stubble.
- b. All row crop stubble until next crop prospect becomes favorable.

II. Moisture Conservation for Continuance of Vegetation.

- 1. Terracing and contour tillage of heavy soils.
- 2. Contour tillage of medium texture soils.
- 3. Contour furrowing of native pastures.
- 4. Contour furrowing of land retired from cultivation to permanent pasture.

III. Emergency Cover Crops.

1. After row crop stand failure.

- a. Drilled sorghum if moisture permits.
- b. Drilled winter grain if moisture permits.

2. After Small grain failure.



a. Substitute sorghum crop.

b. Wide row cover crop.

#### IV. Windbreak Tree Plantings.

1. On sites of natural surface water accumulation.

2. On sites of engineered water retention.

3. On sites supplied with diverted surface water.

#### V. Tillage Operations When Vegetative Cover has Failed.

1. Surface tillage to ridge the surface.

a. Lister.

b. Plow.

c. Wide spaced disk.

d. Pocket digger.

2. Surface tillage to clod the surface.

a. Plow.

b. Harrow.

c. Cultivator, shovel or sweep.

3. Deep tillage to bring up subsurface soil.

a. Chisel

b. Subsoiler.

c. Plow.

D. Disk Plow.

c. Lister.



- a. Substrate vegetation strip.
- b. Wide row cover strip.
- IV. Windbreak Tree Plantings.
1. On sites of natural surface water accumulation.
2. On sites of engineered water retention.
3. On sites equipped with diverted surface water.
- V. Tillage Operations When Vegetative Cover has Failed.
1. Surface tillage to ridge the surface.

- a. Laser.
- b. Plow.
- c. Wide spaced disk.
- d. Trench digger.
2. Surface tillage to level the surface.
- a. Plow.
- b. Harrow.
- c. Cultivator, shovel or sweep.
3. Deep tillage to bring up subsoil.
- a. Subsoil.
- b. Subsoiler.
- c. Plow.
- d. Disk plow.
- e. Laser.



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## Prevention and Control of

Wind Erosion of High Plains..

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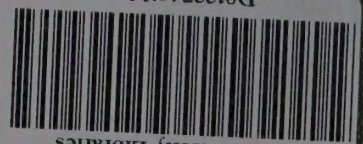
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